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ABSTRACT

This study assessed the ability of third, fifth, and seventh graders to learn a problem-solving heuristic scheme and apply it to grade-appropriate tasks. A framework was utilized that focused on metacognitive aspects of task performance such as planfulness, strategy selection, monitoring, and evaluation. It was expected that use of the scheme would require a degree of reflection about one's own thought processes that might be unavailable to younger students. A football analogy was developed to represent five steps in the problem-solving scheme, with each step associated with an appropriate question. A total of 10 students in each grade were taught the steps and shown how to apply them in everyday situations, concrete puzzles, and reading tasks. They were scored on their ability to remember the steps and use them with other reading passages, both immediately and at a follow-up session two weeks later. It was found that seventh graders could remember the problem-solving steps at follow-up better than the younger students could and were better able to use the scheme in the independent reading tasks. It was concluded that seventh graders, at least, could learn to apply such a scheme to a variety of academic tasks. (Author/RH)

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The Ability of Third, Fifth, and Seventh Graders to Understand and Apply a General Problem-solving Heuristic Scheme

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Abstract

This study was conducted to assess the ability of third-, fifth-, and seventh-graders to learn a problem-solving heuristic scheme and apply it to grade-appropriate tasks. A framework was utilized that focused on metacognitive aspects of task performance, such as planfulness, strategy selection, monitoring, and evaluation. It was expected that use of this scheme would require a degree of reflection about one's own thought processes that might be unavailable to younger students.

A football analogy was developed to represent five steps in the problem-solving scheme, with each step associated with an appropriate question. Ten students in each grade were seen individually on two occasions. Participants were taught the steps and shown how to apply them to everyday situations, concrete puzzles, and reading tasks. They were scored on their ability to remember the steps and use them with other reading passages, both immediately and at two-week follow-up.

Seventh graders could remember the problem-solving steps at follow-up better than the younger students, and they were more successful at using the scheme in the independent reading tasks. These results suggest that seventh graders, at least, could learn to apply such a scheme to a variety of academic tasks.

The Ability of Third, Fifth, and Seventh Graders to Understand and Apply a General Problem-solving Heuristic Scheme

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Current thinking - and practice - regarding the teaching of generalizable problem-solving or thinking skills have tended to take one of two directions (Chipman & Segal, 1985). On the one hand are a growing number of often elaborate programs for the training of general thinking skills. On the other hand are arguments that general thinking strategies may be too content-free and inadequate for the demands of specific domains of knowledge. Instead, effective strategy use may be a function of the acquisition of expertise in a particular domain (Chipman & Segal, 1985; Glaser, 1984).

Though the latter argument may be valid, and while some programs may have had a measure of success in training transferable thinking skills, the kind of approach that may be appropriate for teaching "higher order" or critical thinking skills in elementary or secondary schools is still not clear. Special programs demand a great deal of resources, which are often limited. On the other hand, most students may not acquire sufficient "expertise" in any one (scholastic) domain, even by 12th grade, to become proficient problem solvers or thinkers within that domain. Further, if domain-specific skills or strategies were to be taught, the number adequate to cover the breadth and complexity of the school curriculum would be vast. A viable instructional alternative may be to identify intellectual skills which are, at the same time, content-relevant and general enough to have some utility across a wide range of knowledge domains.

Frequently mentioned as skills which may be generalizable across specific domains are cognitive-control or metacognitive strategies that involve students' abilities to monitor, control, and evaluate their own task performances (Bransford, Arbitman-Smith, Stein, & Vye, 1985; Brown, 1985; Glaser, 1984; Meichenbaum, 1985; Perkins, 1985; and Polson & Jeffries, 1985). Instruction in such strategies may induce students to become more reflective about their own thought processes, as well as about task demands. This reflective attitude may be

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viewed more appropriately as an aspect of cognitive style, as Baron (1985) suggests. In any case, it represents characteristics associated with academic achievement (Baron, 1985). Thus, explicit instruction may help monitoring and self-regulating behaviors become habitual among students who do not acquire them on their own and thereby provide such students with a greater measure of control over academic activities.

The present investigation was designed to gauge the ease with which students of different ages (third, fifth, and seventh graders) could learn to understand a metacognitively oriented heuristic scheme and apply it to age-appropriate tasks. This approach utilized a problem-solving framework that is similar in many respects to familiar conceptions of problem solving (Dewey, 1933; Polya, 1957). It differs from these examples, however, in that it focuses explicitly on metacognitive aspects of task performance, such as planfulness, strategy selection, monitoring of progress, and evaluation of outcome(s).

While the heuristic scheme used in this study may be conceptually simple, its appropriate application to specific tasks may require a degree of reflection about one's own thought processes and task demands that may not be available to most students, without extensive training, before the upper elementary or early secondary grades (Flavell, 1985). Young adolescents, however, may already be using the kind of thinking required by this scheme in many aspects of their daily lives, but they may not generalize it to school tasks. Therefore, third graders were expected to have difficulty applying the scheme, even if they could memorize the steps and complete the tasks successfully. Seventh graders, on the other hand, were expected to apply the heuristic "model" appropriately, once they understood the rationale for its use.

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METHOD

Materials

In order to attract the interest of students, a football analogy was developed to represent five heuristic steps in the problem-solving scheme - "The Goal," "Rules of the Game," "Game Plan," "Keeping Score," and "Final Score." Each of these steps was marked by an appropriate symbol (goalpost, play chart, scoreboard, etc.) and associated with a related question, such as "What do I have to do?," "Is this plan working?." etc. Two charts were used to represent these steps. One, called the "full" chart, contained the symbol, label, and associated questions for each step. Only the symbols appeared on the second chart, which is shown in Figure 1. A concrete puzzle task, a tangram, and three short reading passages were selected for use at each grade level. Grade-level appropriateness was judged by classroom teachers experienced at one or more of the selected grades. (An example of a tangram is presented in Appendix A, and a copy of one of the reading passages is included as Appendix B.) At each grade level, one reading passage was followed by true-false questions, one by a matching task, and one by a crossword puzzle. Correct answers were unambiguous, but a close reading of the text was required to produce them. A group of graduate students, all experienced teachers at either the elementary or junior-high level, assisted the investigator in the selection of grade-appropriate materials and in the development of instructional procedures. Tasks were chosen so that they could be accomplished rather easily by students.

Subjects and Procedure

Five boys and five girls in each of grades 3, 5, and 7 were selected as participants from those judged to be "average" for their grade on the basis of teacher judgment and vocabulary and reading comprehension scores (within one standard deviation of the mean) on the Iowa Test of Basic Skills. Each student was seen individually by one of the teacher-assistants, for a total of about 50 minutes, over two separate sessions. Although specific materials varied by grade, procedures for each student were the same. A detailed script had been developed, and each assistant had been trained to use it.

Students were first shown how the steps in the "full" chart could be used to represent thinking they already used in everyday activities involving planfulness, such as buying a birthday present. After additional practice with similar examples, some supplied by the participants, students were given a puzzle task and helped to relate the solving of it to the steps on the chart. Students were then to try, independently, to match and explain the steps in the tangram task, and the success of each one in doing so was recorded. This procedure incorporated many opportunities for discussion and review.

To assess students' understanding of the problem-solving scheme itself, they were next shown the symbols only chart and asked to name each step and a question associated with it. Then, using the "full" chart, the examiner modeled how the same steps could be used when reading, with a passage which was employed only for this purpose. Subsequently, with two grade-appropriate reading passages, students were given guided prctice and an independent trial in matching the problem-solving sequence to the requirements of the specific reading tasks. Reading passages were counterbalanced across procedural tasks within grade.

At a follow-up session two weeks later, each student was first shown the symbols only chart and asked to name the steps illusted on the chart and to provide an appropriate question for each one. With the "full" chart, each student then read a third reading passage and tried to match the steps on the chart to the requirements of the specified task. Success on each of these activities was recorded.

RESULTS

Three kinds of data were produced by this procedure - counts of each task successfully completed (five possibilities), scores on the two step-naming occasions, and scores for the three step-matching occasions. A step-naming response was considered correct only if both the step label and an associated question were provided.

As expected, performance on the five tasks (puzzle, tangram, and three reading passages) was near ceiling at each grade level. Two third-grade students each failed to complete correctly one of the reading tasks (different ones). One fifth grader could do

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neither the puzzle nor the tangram without help, and another fifth grader could not complete the puzzle independently. Two seventh graders had trouble with their tangram, while another seventh grader could not complete one reading task successfully.

Non-parametric tests were used to assess performance across grades on the step-naming and step-matching tasks because of the near perfect scores of the seventh graders on all but the first step-naming occasion. The maximum score for each of these tasks was a 5. A Kruskal-Wallis one-way analyis of variance by ranks was performed in each instance. Differences across grades on the first step-naming task were not significant (score means of 3.5, 4.3, and 4.1, for grades 3, 5, and 7, respectively). However, seventh graders' scores on the follow-up step-naming task were nearly perfect, and grade-level differences were significant (chi-square of 13.68, $p < 0.002$). Score means were 3.1, 3.6, and 4.8, respectively.

Differences across grades were also significant on each step-matching task, with seventh graders out-performing other students in each instance. The analysis for the tangram produced a chi-square value of 9.37 ($p < 0.01$), with respective score means of 4.0, 4.2, and 5.0, for grades 3, 5, and 7. For the first independent reading passage, the chi-square value was 13.46 ($p < 0.002$), and score means were 3.3, 4.1, and 5.0, respectively. On the follow-up reading task, the score means, respectively, were 1.8, 3.7, and 4.9, and the Kruskal-Wallis analysis produced a chi-square value of 16.13 ($p < 0.001$).

CONCLUSION

The results obtained by the Kruskal-Wallis analyses were underscored by anecdotal reports by the examiners. Seventh graders, apparently, readily grasped the purpose of the heuristic scheme and could follow the steps in the sequence without difficulty. Therefore, a heuristic device such as this one could probably be taught to adolescents rather easily to help them develop a habit of self regulation regarding school tasks that they could use across curricular areas. On the other hand, this general scheme, alone, may be inadequate

for achieving such a purpose with younger children, who may require a more explicit and prolonged program of instruction in order to acquire similar metacognitive behaviors.

This heuristic scheme, however, presupposes that its user possesses the requisite domain-specific knowledge or skills to accomplish the task to which it is applied. Therefore, it cannot substitute for such content knowledge, which must be acquired separately. This scheme, though, conceivably could serve to alert someone as to whether his or her current state of knowledge was sufficient to reach the intended goal. In a sense, then, it could function as a general monitoring device, guiding someone in progress toward a goal or indicating where remedial action may be needed.

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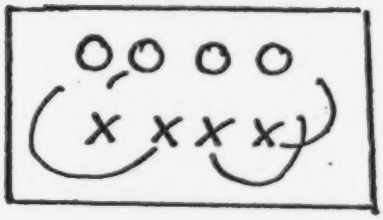
CAN YOU REACH THE GOAL?

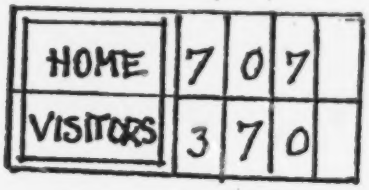
1.

2.

3.



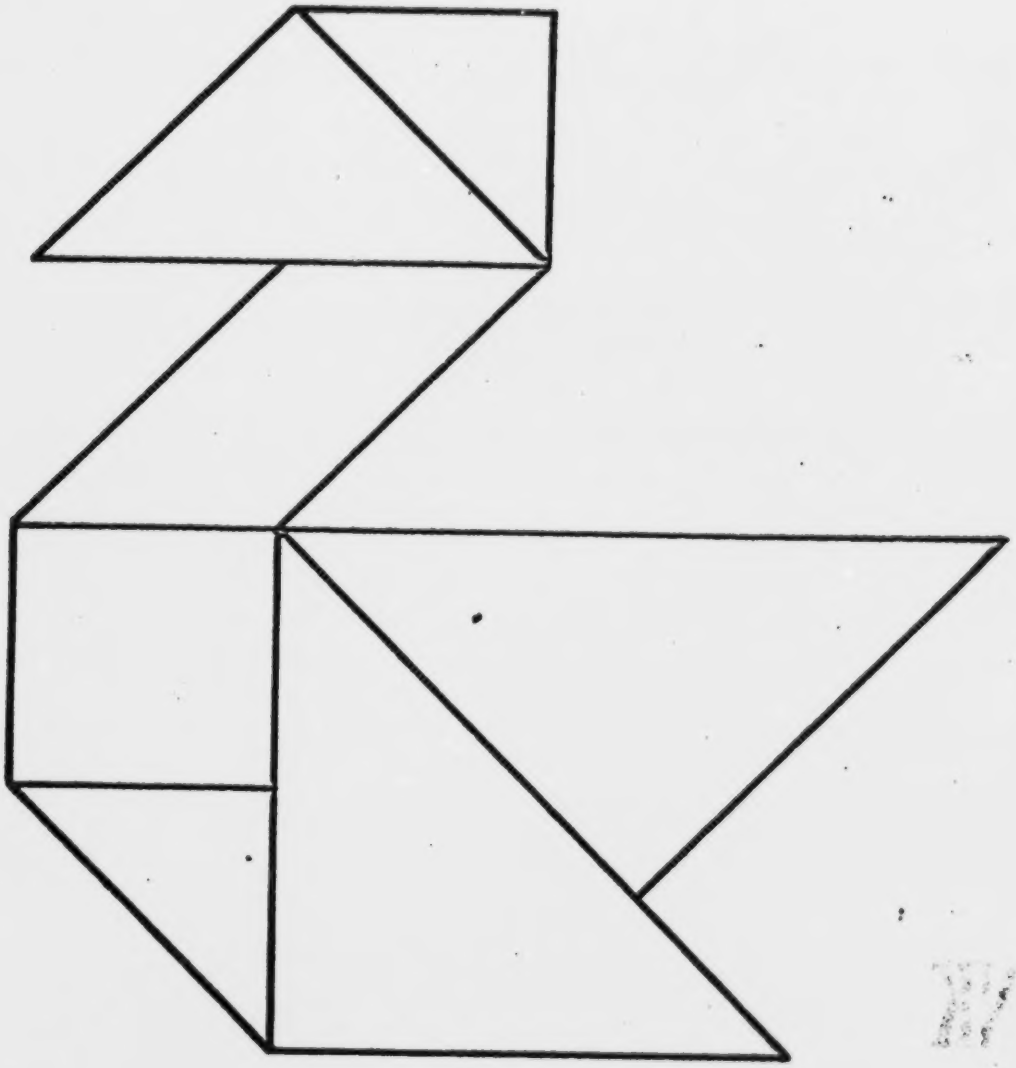
4.



5.

FIGURE 1

APPENDIX A



WHO WORE THESE HATS?

Pikeville was like most other towns except for one thing. People wore hats. Not just in cold weather -- but all the time. And the really strange thing was that once someone chose a color hat to wear, he or she wore that color from then on. So it was not surprising that people became known by the color of their hats.

The people I knew in Pikeville wore green, red, yellow, purple, and blue hats. The tallest man in town wore the red hat; the shortest man wore the purple one. The smartest woman wore green hats, while her sister wore those that were blue. The police chief of Pikeville wore yellow hats when he wasn't on duty. Janet was the smartest lady. Sue was her sister. The name of the police chief was Roger. The shortest man in Pikeville was Charlie. Tom, on the other hand, was the tallest man.

WHO WORE THESE HATS?

Sue

Charlie

Roger

Tom

Janet

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